RACE: Risk assessment of chytridiomycosis to European amphibian biodiversity

Fisher, M C ; Schmidt, B R ; Henle, K ; Schmeller, D S ; Bosch, J ; Aanensen, D M ; Miaud, C ; Garner, T W J

March 2012 Vol. 101

ISSN: 1026-0269
eISSN: 1817-3934

froglog

www.amphibians.org

Conservation news for the herpetological community

Regional Focus

Europe, North Africa and West Asia

Trying to reverse the decline of the Apennine yellow-bellied toad in northern Italy. Page 24

Photo: Emanuele Biggi

INSIDE

"Top 10" Lost Frogs of 2012

40 Years of Natterjack Toad Conservation in Europe

frog log

CONTENTS

RACE: Risk Assessment of Chytridiomycosis to European Amphibian Biodiversity

By Matthew C. Fisher, Benedikt R. Schmidt, Klaus Henle, Dirk S. Schmeller, Jaime Bosch, David M Aanensen, Claude Miaud & Trenton W. J. Garner

Batrachochytrium dendrobatidis (*Bd*) is now known to be a proximate cause of amphibian declines on five continents. *Bd* infects more than 500 species of amphibians and infections in wild amphibians are reported for 54/81 countries for which data are available (http://www.bd-maps.net/surveillance/). At its worst, emergence of *Bd* leads to a 70% loss of local amphibian biodiversity in a matter of months (reviewed by Fisher et al. 2009). Lethal chytridiomycosis affecting midwives (*Alytes obstetricans*) was discovered at what is now considered the European Index site for *Bd,* the Peñalara Natural Park (Spain) in 2001 (Bosch et al. 2001). Further research showed that the infection in European amphibians was widespread (Garner et al. 2005). In response to what could be a significant threat to Europe's amphibians we established a collaborative project among seven institutions based in five countries. The project *RACE* is funded by the FP7 ERA-NET project BiodiverERsA (http://www.biodiversa.org/) and is designed to develop a European-wide scientific program in response to the detection of lethal chytridiomycosis in Europe. The specific goals of *RACE* are:

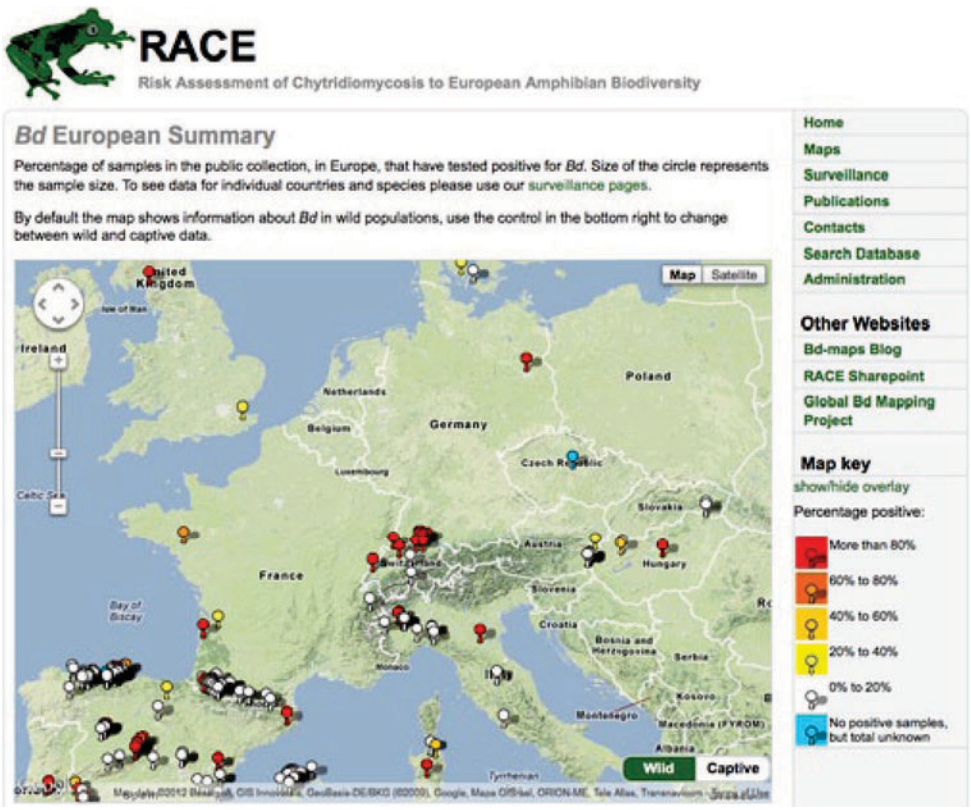

Figure 1. The EU RACE infection summary page at www.bd-maps.eu.

- *Identification of natural and anthropogenic drivers of chytridiomycosis.*
- *Development of an informatics solution to acquire field data.*
- *Analysis of species' susceptibility and environmental drivers across scales.*
- *Assess the effectiveness and efficiency of policy instruments to respond to emerging infectious diseases and disease-related biodiversity loss.*
- *Disseminating results to a range of relevant policy makers, public sector representatives, land users, NGOs, scientists, and the general public.*

At its heart, *RACE* is a risk assessment, the first of its kind in Europe, designed to assess if and how *Bd* may threaten our amphibian fauna. If a threat is detected, the project is designed to produce and disseminate a European Threat Abatement Plan (ETAP) in 2013, to aid the European Parliament in developing an appropriate response to the threat. Since its initiation in 2009, *RACE* has achieved significant milestones. Foremost has been the development of an extensive network outside the seven core *RACE* groups. The combined effort of the associated groups (extra*RACE*rs) and the original seven has resulted in a significantly increased understanding of the distribution of *Bd* and chytridiomycosis across Europe. Extensive surveillance is completed, or underway, in the UK, France, Spain, Switzerland, Austria, the Czech Republic, the Netherlands, Belgium, Italy and Hungary, with other countries gearing up to assess the scale of infection. An informatics database has been established that allows the prevalence of infection to be assessed across various geographic scales. This web application can be accessed at the *RACE* project web site (www.bd-maps.eu/) with surveillance data summarised (www.bd-maps.eu/stats.php).

Figure 2. *RACE* inaugural meeting, 2009 (Dirk Schmeller).

Figure 3. *RACErs* disinfecting after fieldwork in the Pyrenees, Lac Arlet 2009 (Mat Fisher).

The European patterns of infection, originally described in a study by three of the seven founding members of *RACE* (Garner et al. 2005), holds up to some degree: *Bd* is widespread across Europe. Eleven out of 15 countries providing data to *RACE* have infected amphibians in the wild. However, previous estimates of prevalence sorely underestimated how heavily *Bd* had penetrated Europe. Prevalence in Switzerland, Austria, France and the UK were all seriously underestimated in the earlier study [respectively, Switzerland current estimate, 54% (unpublished), previous estimate 25%; Austria current 20% (Sztatecsny and Glaser, 2011), previously 0%; France current 34% (unpublished), previously 0%; UK current 26% (unpublished) previously <1%]. Other national estimates currently available include Spain (~25%; Walker et al. 2008) and the Netherlands/ Belgium (~30%). The overall prevalence for Europe stands at 27% (1351 positives/ 4999 samples).

Several European species other than *A. obstetricans* are experiencing substantial mortality in the wild due to chytridiomycosis (e.g., (Bielby et al. 2009; Garner et al. 2009a) and *A. obstetricans* is dying from chytridiomycosis outside of Iberia (Tobler and Schmidt, 2010; Walker et al. 2010; Pasmans et al. 2010). Amphibian species currently described in the literature that are experiencing lethal chytridiomycosis are undoubtedly an underestimate of the full range of susceptible European hosts. Mass-mortalities are generally detected at locally high-altitude montane regions but temperatures associated with mortality in *A. obstetricans* are not the same at different locations. At the index site, death followed the globally 'typical' pattern based on lab-based estimates of *Bd* temperature requirements (Bosch et al. 2007), while in the Pyrenees, atypically colder temperatures were associated with mass mortality (Walker et al. 2010). In addition, a correlation with UV-B has been observed at both sites and in both natural and experimental settings, suggesting a role for levels of radiation in governing the intensity of infection (Walker et al. 2010; Ortiz-Santaliestra et al. 2011). However, several species may be tolerant or even resistant to infection (e.g., Luquet et al. 2012). *RACE* team members have identified numerous populations, communities and areas across Europe where *Bd* is not associated with detectable mortality, even at high prevalence. In Switzerland, despite significant reduction in the numbers of *A. obstetricans* populations, *Bd* has not been confirmed as a cause of these declines.

The inconsistent pattern of chytridiomycosis in Europe may in part be explained by a recent significant *RACE* finding. *Bd* is composed of at least three divergent lineages (*Bd*GPL, *Bd*CH and *Bd*CAPE) of variable virulence (Farrer et al. 2011). The most virulent lineage, *Bd*GPL, is the only widespread lineage and is the one associated with mortality and the increasing spread of disease evident in Iberia, as well as on other continents. This study and a previous study by Walker et al. (2008) also provide the first well-supported evidence that *Bd* was introduced to Europe. *Bd*CAPE infecting *Alytes muletensis* on Mallorca is only found outside of Europe in South Africa. This unusual pattern is best explained by the introduction of *Bd*CAPE into Europe by an infected South African endemic, *Xenopus gilli*. The third lineage remains enigmatic: *Bd*CH infecting *Alytes obstetricans* in Switzerland has only been isolated once. Additional *Bd* isolation and sequencing is underway.

Substantial effort is now being undertaken to identify the vectors of infection, as well as develop means to control spread of *Bd*. *RACErs* have also expended considerable effort in attempting to mitigate infection by removing animals and clearing infection *ex situ* by the use of the antifungal drug itraconazole (Garner et al. 2009b; Schmeller et al. 2011) and elevated temperature (Geiger et al. 2011). Currently, this has been ineffective in clearing infection for study sites on Mallorca however antifungal treatment has reduced the intensity of infection. This suggests that mitigation may alter the host/ pathogen dynamics in ways that may protect amphibians from the lethal effects of infection (Woodhams et al. 2011). Future control protocols will likely not involve clearing the pathogen, but will instead focus on *in situ* methods for reducing the intensity of infection.

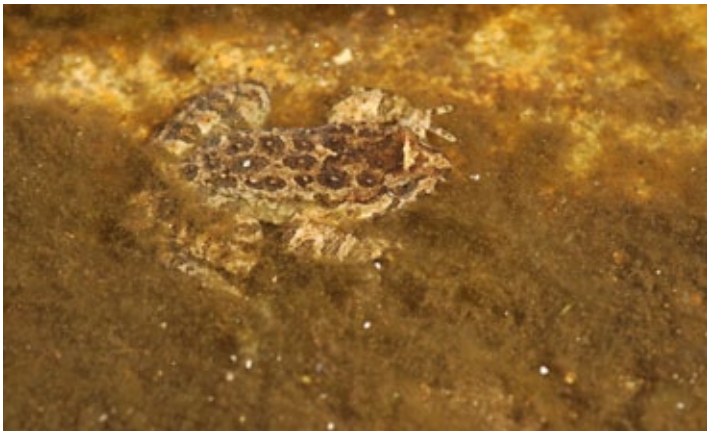

Figure 4. (a) The Sardinian brook newt, *Euproctus platycephalus*, and (b) Tyrrhenian painted frog *Discoglossus sardus*. Both species have been identified by *RACE* as infected by BdGPL (Trent Garner).

Figure 5. *Alytes obstetricans* chytridiomycosis mass mortalities in the Pyrenees. Photo Mat Fisher.

News, updates and reports from *RACE* are regularly recorded at our project blog and can be viewed at http://bd-maps.blogspot.com/

Author details: MCF and DMA are at Imperial College London, UK; BRS is at Koordinationsstelle fuer Amphibien- und Reptilienschutz in der Schweiz (karch), Switzerland; KH is at UFZ, Germany; DSS is at the CNRS, France; CM is at the Universite de Savoie, France; JB is at the Museo Nacional de Ciencias Naturales, Spain; TWJG is at the Institute of Zoology, UK.

Literature Cited

Bielby, J., S. Bovero, G. Sotgiu, G. Tessa, M. Favelli, C. Angelini, S. Doglio, F. C. Clare, E. Gazzaniga, F. Lapietra and T. W. J. Garner (2009) Fatal Chytridiomycosis in the Tyrrhenian Painted Frog. Ecohealth 6(1): 27-32.

Bosch, J., L. M. Carrascal, L. Duran, S. Walker and M. C. Fisher (2007) Climate change and outbreaks of amphibian chytridiomycosis in a montane area of Central Spain; is there a link? Proceedings of the Royal Society B-Biological Sciences 274(1607): 253-260.

Bosch, J., I. Martínez-Solano and M. García-París (2001) Evidence of a chytrid fungus infection involved in the decline of the common midwife toad (*Alytes obstetricans*) in protected areas of central Spain. Biological Conservation 97: 331-337.

Farrer, R. A., L. A. Weinert, J. Bielby, T. W. J. Garner, F. Balloux, F. Clare, J. Bosch, A. A. Cunningham, C. Weldon, L. H. du Preez, L. Anderson, S. L. K. Pond, R. Shahar-Golan, D. A. Henk and M. C. Fisher (2011) Multiple emergences of genetically diverse amphibian-infecting chytrids include a globalized hypervirulent recombinant lineage. Proceedings of the National Academy of Sciences of the United States of America 108(46): 18732-18736.

Fisher, M. C., T. W. J. Garner and S. F. Walker (2009) Global Emergence of Batrachochytrium dendrobatidis and Amphibian Chytridiomycosis in Space, Time, and Host. Annual Review of Microbiology 63: 291-310.

Garner, T. W. J., S. Walker, J. Bosch, S. Leech, J. M. Rowcliffe, A. A. Cunningham, and M. C. Fisher (2009a) Life history trade-offs influence mortality associated with the amphibian pathogen *Batrachochytrium dendrobatidis*. Oikos 118: 783-791.

Garner, T. W. J., G. Garcia, B. Carroll and M. C. Fisher (2009b) Using itraconazole to clear Batrachochytrium dendrobatidis infection, and subsequent depigmentation of Alytes muletensis tadpoles. Diseases of Aquatic Organisms 83(3): 257-260.

Garner, T. W. J., S. Walker, J. Bosch, A. D. Hyatt, A. A. Cunningham and M. C. Fisher (2005) Chytrid fungus in Europe. Emerging Infectious Diseases 11(10): 1639-1641.

Geiger, C. C., E. Küpfer, S. Schär, S. Wolf and B. R. Schmidt (2011) Elevated temperature clears chytrid fungus infections from tadpoles of the Midwife toad, *Alytes obstetricans*. Amphibia-Reptilia 32(2): 276-280.

Luquet, E., T. W. J. Garner, J.-P. Léna, C. Bruel, P. Joly, T. Lengagne, O. Grolet and S. Plénet (2012) Does genetic erosion influence the impact of exposure to infectious disease? *Evolution* doi:10.1111/j.1558-5646.2011.01570.x

S. Plénet (in press) Does genetic erosion influence the impact of exposure to infectious disease? *Evolution*

Ortiz-Santaliestra, M. E., M. C. Fisher, S. Fernandez-Beaskoetxea, M. J. Fernandez-Beneitez and J. Bosch (2011) Ambient Ultraviolet B Radiation and Prevalence of Infection by *Batrachochytrium dendrobatidis* in Two Amphibian Species. Conservation Biology 25(5): 975-982.

Pasmans, F., M. Muijsers, S. Maes, P. Van Rooij, M. Brutyn, R. Ducatelle, F. Haesebrouck and A. Martel. (2010) Chytridiomycosis related mortality in a Midwife toad (*Alytes obstetricans*) in Belgium. Vlaams Diergeneeskundig Tijdschrift 79: 461-463.

Sztatecsny, M. and F. Glaser (2011) From the eastern lowlands to the western mountains: first records of the chytrid fungus *Batrachochytrium dendrobatidis* in wild amphibian populations from Austria. Herpetological Journal 21(1): 87-90.

Schmeller D.S. , Loyau A., Dejean T., Miaud C. (2011) Using amphibians in lab studies – precautions against the emerging infectious disease Chytridiomycosis. Laboratory Animals 45: 25-30.

Tobler, U. and B. R. Schmidt (2010) Within- and Among-Population Variation in Chytridiomycosis-Induced Mortality in the Toad *Alytes obstetricans*. PLoS ONE 5(6): e10927.

Walker, S. F., J. Bosch, V. Gomez, T. W. J. Garner, A. A. Cunningham, D. S. Schmeller, M. Ninyerola, D. A. Henk, C. Ginestet, C. P. Arthur and M. C. Fisher (2010) Factors driving pathogenicity vs. prevalence of amphibian panzootic chytridiomycosis in Iberia. Ecology Letters 13(3): 372-382.

Walker, S. F., J. Bosch, T. Y. James, A. P. Litvintseva, J. A. O. Valls, S. Pina, G. Garcia, G. A. Rosa, A. A. Cunningham, S. Hole, R. Griffiths and M. C. Fisher (2008) Invasive pathogens threaten species recovery programs. Current Biology 18(18): R853-R854.

Woodhams, D. C., J. Bosch, C. J. Briggs, S. Cashins, L. R. Dacvis, A. Lauer, E. Muths, R. Piuschendorf, B. R. Schmidt, B. Shaeafor and J. Voyles (2011) Mitigating amphibian disease: strategies to maintain wild populations and control chytridiomycosis. Frontiers in Zoology 8(8). doi:10.1186/1742-9994-8-8.